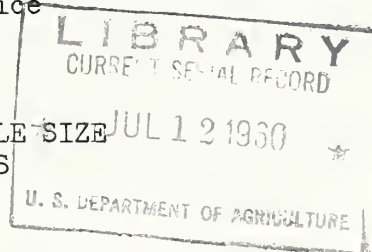


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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research ServiceA METHOD OF DETERMINING PARTICLE SIZE
OF LIQUEFIED-GAS AEROSOLSBy A. H. Yeomans
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A satisfactory method of determining the particle size of liquefied-gas aerosols is to deposit a sample on a glass slide and measure the particles under a high-power microscope. The temperature of the formulation and dispenser is set at 80° F.

Preparation of Slide

The slide (1 by 3 inches) is coated with an oleophobic substance that will cause the droplets to retain some of their convexity and prevent irregular spreading on the slide. A satisfactory material is a 10-percent solution of Dri-film SC-87 (General Electric Co.)^{1/} in toluene. The slide is immersed in a cleaning solution, dried, immersed in the oleophobic-coating solution, and then after a few seconds lightly polished with a soft cloth. (Fumes from the Dri-film should not be inhaled.) A slide coated with this material can be used for many samples, if it is washed with acetone after each use. When the droplets no longer remain circular, the slide should be recoated.

Deposition of Particles on Slide

The method of depositing the droplets on the slide depends on their size. For aerosols in which all the particles are less than 50 microns in diameter but the mass median diameter is more than about 8 microns, either the slide can be waved horizontally through the aerosol cloud toward the release point or an impactor can be used (fig. 1). This impactor consists of a 2,000 cubic-feet-per-minute ventilating fan (A) which draws the aerosol through a tube (B) 20 inches in diameter and 60 inches long. The aerosol is released at the center of one end of this tube so that it is carried toward the fan at the other end. At 42 inches from the release point and in front of the fan, the slide is revolved on a 4-inch radius at 400 r.p.m. This is done by means of a counterbalanced slide holder (C) turned by a variable-speed stirrer motor (D) (Central Scientific Co. No. 18805).^{1/} The optimum air flow and the speed of revolving the slide in this impactor were determined from many tests but are not critical.

^{1/} Mention of these manufacturers does not constitute endorsement of their products by the Department of Agriculture.

The slide holder (E) is made with three edges bent 1/16 inch over the face of the slide so that it can be pushed in easily and the 1-inch open end of the holder can face the release point of the aerosol. The slide revolves counterclockwise with its exposed face in the direction of rotation. The outside 3-inch edge is located ahead of the bottom edge, making a 25° angle between the face of the slide and the 4-inch turning radius, in order to minimize sliding of the droplets due to centrifugal force.

The time the slide is exposed to the aerosol is important. If too many particles are allowed to deposit on the slide, some will fall on top of others and give a false reading. It is best to expose the slide long enough for about 0.3-0.5 gram of the formulation to be released. This can be accomplished on the impactor by lowering the revolving slide quickly into the stream of aerosol. If the slide is passed by hand through the aerosol it must be done at a distance of approximately 42 inches from the release point.

Determination of Particle Size

After the aerosol is deposited on a slide, it is placed under a microscope, and the particles are measured with an eyepiece micrometer having 50 divisions, each division equal to 15.4 microns. A 100-power microscope is best for particles of aerosol size. A mechanical stage on the microscope is necessary. The diameter as measured on the slide is then corrected for the spread that takes place so that the diameter of the original sphere can be determined.

At least 200 particles should be measured. All the particles from one edge of the slide to the other are counted as the slide is moved by the mechanical stage. Representative data illustrating this method are given in table 1.

Table 1.--Size distribution of aerosol particles impinged on microscope slide

Diameter (D) (scale divisions)	Number (N) of particles	DN	Percent of total DN	
			In each size	Accumulative
0.5	2	1	0.2	0.2
1.0	26	26	6.3	6.5
1.5	33	49.5	11.9	18.4
2.0	82	164	39.5	57.9
2.5	34	85	20.5	78.4
3.0	17	51	12.3	90.7
3.5	4	14	3.4	94.1
4.0	5	20	4.8	98.9
4.5	1	4.5	1.1	99.9
Total	204	415.0		

The diameter (D) is used in the first power only. The mass median diameter is computed on the basis of volume, which is in ratio to D^3 , but the particles impinge in ratio to D^2 . Therefore, the number of particles is multiplied by D^3/D^2 , or by D.

The accumulative percentages are plotted on an logarithmic probability scale (No. 3128, Codex Book Co.).^{1/} The 50-percent point of the line so plotted is taken as the median of the particles as they appear on the slide.

A correction factor must be determined for each slide. The spherical droplet as it impinges on the slide becomes a convex lens, and its spread from its original shape can be calculated by determining the focal length of this lens by the method described by May.^{2/}

Procedure for Measuring Spread Factor of Oil Droplets on Oleophobic Slides

Use a compound high-power microscope but remove the condenser and use the flat mirror with outside light. Focus on a particle the diameter of which before correction is approximately 30 microns, and record this reading of fine-focus adjustment. Manipulate the fine-focus adjustment and mirror until some distant object (window frame) is in as sharp a focus as possible, using the drop as a lens, and record this reading of fine-focus adjustment. The difference between the two readings of the fine-focus adjustment is the focal-length change.

$$\frac{\text{Focal-length change}}{\text{Diameter of particle}} = \text{Spread factor}$$

Select the correction factor that corresponds to the spread factor as follows:

<u>Spread</u>	<u>Correction</u>	<u>Spread</u>	<u>Correction</u>	<u>Spread</u>	<u>Correction</u>
1.48	0.60	2.0	0.48	4.0	0.38
1.50	.58	2.1	.47	4.8	.35
1.55	.55	2.2	.46	5.0	.34
1.60	.54	2.3	.45	5.5	.33
1.65	.53	2.6	.44	6.0	.32
1.70	.52	2.7	.43	6.8	.31
1.75	.51	2.8	.42	7.0	.30
1.80	.50	3.1	.41	8.0	.29
1.95	.49	3.3	.40	10.0	.27

Example: A particle covering two scale divisions on the micrometer has a diameter of 30.8 microns. With a focal-length change of 103 microns, the spread factor would be $103/30.8$, or 3.3. The corresponding correction factor would be 0.40. Therefore, $30.8 \text{ microns} \times 0.40$ gives a median particle diameter of 12.3 microns.

^{2/} May, K. R. 1945. The cascade impactor. An instrument for sampling coarse aerosols. Jour. Sci. Instr. 22: 187-195.

Reporting Particle Size

The particle size of a liquefied-gas aerosol should be reported not only by mass median diameter but also by the accumulative percentage for each 5 microns in diameter up to 50 microns. This percentage can be obtained from table 1, after the correction factor is determined. The 5-micron-diameter points are calculated in terms of microns from the scale divisions, and then the corresponding accumulative percentage is interpolated from the value in the last column.

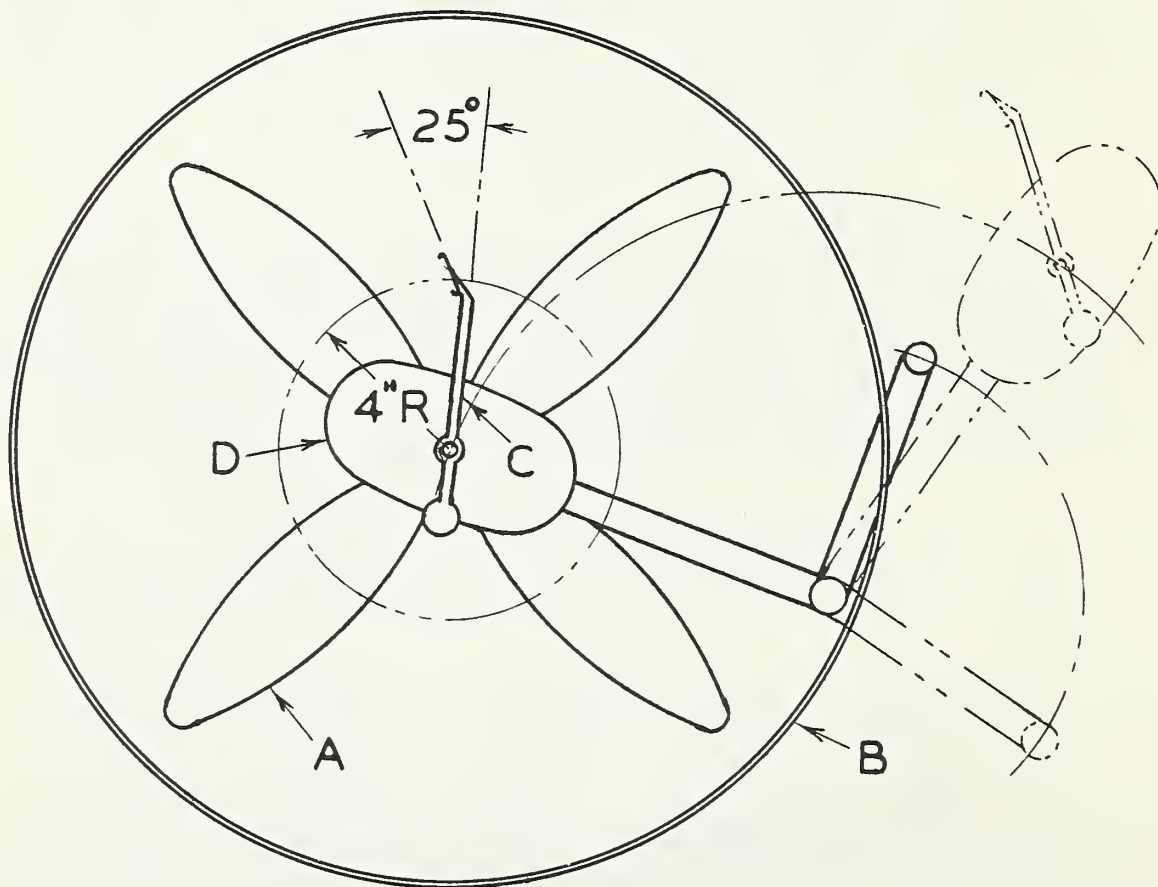


Figure 1.--Impactor for sampling aerosols, looking from the release point through the tube toward the fan: A, ventilating fan; B, tube; C, slide holder; D, stirrer motor.

